Global Tropospheric Experiment Amazon Boundary Layer Expedition 2A (ABLE 2A) Langley ASDC Data Set Document

Summary

This document provides information on data products obtained during the GTE ABLE 2A atmospheric science expedition conducted over the Amazon during July and August 1985. The objective of the mission was to characterize the chemistry and dynamics of the lower atmosphere over the Amazon Basin during the early-to-middle dry season. Measurements were made primarily by investigators' instruments located on the NASA Wallops Electra airborne laboratory. Also provided are a list of principal investigators, a brief summary of measurement techniques and a list of publications.

This document provides information for the following five data sets:

- **gte_able2a_aircraft_msn_02.zip** - ABLE 2A Electra Aircraft Data
- **gte_able2a_ground.zip** - ABLE 2A Ground Data

Acknowledgment

NASA funded the investigators involved in the ABLE 2A mission.
The funded investigators, their organization and their grant, agreement or contract numbers were:

Area	Investigator	Organization	Grant
Aircraft	M. O. Andreae	Florida State U	NAG-1-588
	S. M. Beck	NASA Langley	N/A
	Edward Browell	NASA Langley	N/A
	M. Garstang	U of Virginia	NCC-1-95
	Gerald Gregory	NASA Langley	N/A
	R. A. Rasmussen	Oregon Grad Ctr	NAG-1-589
	Glen Sachse	NASA Langley	N/A
	R. W. Talbot	Bionetics Corp	NAS-1-16978
	A. L. Torres	NASA Wallops	N/A
	S. C. Wofsy	Harvard U	NAG-1-55
Surface	David Fitzjarrald	State U of New York-Albany	NAG-1-583
	R. C. Harriss	NASA Langley	N/A
	C. L. Martin	Simpson Weather Assoc	N/A
	D.I. Sebacher	NASA Langley	N/A
	Steven Wofsy	Harvard U	NAG-1-55
	P. R. Zimmerman	NCAR	N/A
AGE	R. C. Harriss	NASA Langley	N/A
	P. A. Matson	NASA Ames	N/A
	J. M. Melack	U of California-Santa Barbara	NCC-1-82
	J. E. Richey	U of Washington	NAGW-711
	P. Vitousek	Stanford U	N/A
Satellite	S. T. Shipley	NASA Langley	N/A

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1. Collection Overview

a. Collection Contents

Aircraft data sets are available for each investigation for each flight. Ground-based data are usually available on a daily basis. Airborne measurements were typically obtained at constant altitude during transit flights (i.e. "survey" flights), and over multiple altitudes closer flights from the intensive sites. Flight missions were conducted during ABLE 2A from July through August 1985. Section 4.b lists the flight dates. The duration, altitude range, ascent and descent rate, and flight path for each mission varied depending on mission objectives and environmental (weather) conditions. The automated ground sites provided daily measurements during the time frame when airborne measurements were being made and weekly averaged samples before and after. Further information about the measurement region and time frame may be found in the Journal of Geophysical Research, Vol. 93, No. D2, February 20, 1988.

Data Set Introduction

This data set contains all of the data submitted to the GTE data archive by the ABLE 2A investigators listed in Section 1.d. Included are the atmospheric chemistry, meteorological and navigational data recorded aboard the NASA Wallops Electra airborne laboratory, data obtained from surface level sites, sonde and balloon data and all of the merged data sets. Note that the ASDC data link points the user to the GTE data archive to obtain the data.

Summary of Parameters

The atmospheric species and other parameters measured are listed in Section 4.c and in Harriss et al., [1988]. Also listed for each are the name and affiliation of the principal investigator.

b. Related Data Collections

ABLE 2A investigators have individually reported the results of their investigations in the Journal of Geophysical Research, Vol. 93, No. D2, February 20, 1988.

There are data sets available from the Langley ASDC for 13 other GTE missions conducted from 1983 to 2001. See the GTE home page and/or the ASDC GTE Data Table for a description of the available data.

c. Title of Investigation

Global Tropospheric Experiment Amazon Boundary Layer Expedition 2A (ABLE 2A)

d. Investigator Name and Title

If the person is known to be retired, deceased or no longer at the organization originally responsible for the experiment, it is noted and the contact information may be omitted. The contact information provided was current during the mission, but may no longer be current.

Electra Investigators

Investigator Area	Investigator Information
Gaseous Sulfur Species	M. O. Andreae (no longer at FSU) Florida State University Department of Oceanography Tallahassee FL 32306 Telephone: 904-644-1221
Airborne Meteorological/Navigation Data and H_2O	S. M. Beck (no longer at NASA LaRC) NASA Langley Research Center
Aerosol and Ozone Profiles	Edward V. Browell Mail Stop 401A NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-1273 Fax: 757-864-7790 E-mail: edward.v.browell@nasa.gov
In-situ Ozone and Aerosol Number Density and Size Distribution	Gerald L. Gregory (retired) NASA Langley Research Center
Hydrocarbons, Isoprene, C_1C_5 Alkanes, Organic Acids, Aldehydes, Ketones, Alcohols, Methyl halides, Halocarbons	R. A. Rasmussen Oregon Graduate Center Department of Environmental Science 19600 N. W. Walker Road Beverton OR 97006-1999 Telephone: 503-645-1121 E-mail: rrasmus@ese.ogi.edu
Carbon Monoxide	Glen W. Sachse MS 483 NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-1566 Fax: 757-864-5841 E-mail: glen.w.sachse@nasa.gov
Aerosols	A. W. Setzer INPE Department of Meteorology C.P. 515 12.200 - San Jose dos Campos - SP Brazil Telephone: 55-123-229977
Aerosol Composition	Robert W. Talbot (now at UNH) Bionetics Corp.
Nitric Oxide, Nitrogen Dioxide	B. L. Torres (retired) NASA Wallops
Carbon Dioxide	S. C. Wofsy Center for Earth and Planetary Physics Pierce Hall 29 Oxford Street Harvard University Cambridge MA 02138 Telephone: 617-495-4566 Fax: 617-495-9837 E-mail: scw@io.harvard.edu

Ground-based Measurements Investigators

Investigator Area	Investigator Information

Micrometeorology	E. M. C. Cutrim Federal University of Para Department of Meteorology Centro de Geociencias 66000 Belem, Para Brazil Telephone: 11-55-91-226-181 E-mail: elen.cutrim@wmich.edu	P. L. S. Dias Department of Meteorology Instituto Astronomico e Geofisico (IAG) University de Sao Paulo Caixa Postal 306ZF 01000 Sao Paulo, SP Brazil Telephone: 55-11-212-3037	C.A. Nobre INPE
Eddy Heat and Moisture Fluxes	D. R. Fitzjarrald Atmospheric Sciences Research Center SUNY-Albany 100 Fuller Road Albany NY 12005 Telephone: 518-442-3838 Fax: 518-442-3867 E-mail: fitz@asrc.cestm.albany.edu		
Surface Fluxes of Heat Momentum and Water Vapor	M. Garstang University of Virginia Department of Environmental Sciences Clark Hall Charlottesville VA 22903 Telephone: 804-979-3571 Fax: 804-977-3733 E-mail: mxg@thunder.swa.com		
Ozone	V. W. J. H. Kirchhoff Instituto Nacional de Pesquisas Espaciais C. P. 515 12201 Sao Jose dos Campos Sao Paulo, Brazil Telephone: (55) 123-41-8977 Fax: (55) 123-21-8743		
Limnology	J. M. Melack University of California - Santa Barbara Telephone: 805-893-3879 E-mail: melack@lifesci.ucsb.edu		
Wind and Temperature Profiles, Radiation and Rainfall	L. C. B. Molion INPE Department of Meteorology C.P. 515 12.200 - Sao Jose Dos Campos - SP Brazil		
Precipitation Chemistry	L. M. Moreira-Nordemann INPE		
Aerosols	P. Artaxo Netto University of Sao Paulo Instituto de Fisica Caixa Postal 66318 CEP 05389-970, Sao Paulo SP Brazil Telephone: 55-11-818-7016 Fax: 55-11-818-6749		
Solar Radiation	H. S. Pinheiro Federal University of Para		
Methane	D.I. Seabacher (no longer at NASA LaRC) NASA Langley Research Center		
Aerosols and Satellite Imagery	A.W. Setzer INPE Department of Meteorologia C.P. 515, 12.200 Sao Jose Dos Campos Sao Paulo Brazil Telephone: 011-55-123-22-9977		
CO_2, CO, N_2O, NO, NH_3	S. C. Wofsy (See above prior entry)		
Hydrocarbon Fluxes	P. A. Zimmerman		

	NCAR P. O. Box 3000 Boulder CO 80307 Telephone: 303-497-1406 E-mail: zimmer@ucar.edu

AGE Program Investigators

Investigator Area	Investigator Information
Methane and Carbon Dioxide	J. E. Richey University of Washington College of Ocean and Fishery Sciences Seattle WA 98195 E-mail: jrichey@u.washington.edu
Nitrous Oxide	P. Vitousek Stanford University HERRIN LABS RM 498A Mail Code 5020 Stanford, California, 94305-5020 Telephone: 650) 725-1866 Fax: (650) 725-1856 E-mail: vitousek@stanford.edu

e. Technical Contact(s)

The following persons have more specialized knowledge about the data in the data sets or in their field or general knowledge about the mission, its execution and the data sets.

Investigator or Knowledge Area	Investigator and Contact Information	
Aerosol Composition, Organic Acids, CO_2	R. C. Harriss (See prior above listing)	
ABLE 2A Mission Scientist and Associate Mission Scientist	R. C. Harriss (See prior listing above)	S. C. Wofsy (See prior listing above)
Associate Mission Scientists and INPE Coordinators	A. G. Motta Coordenadoria Adjunta Natal/Fortaleza INPE Av. Salagado Filhno No 3000 Brazil	L. C. B. Molion (See prior above listing)
ABLE 2A Program Manager	Robert J. McNeal (retired) NASA Headquarters	
ABLE 2A Project Manager	James M. Hoell, Jr. (retired) NASA Langley Research Center	
ABLE 2A Mission Meteorologist	M. Garstang (See prior above listing)	
ABLE 2A Expedition Manager	Richard J. Bendura (retired) NASA Langley Research Center	
Aircraft Operations and Experiments Manager	S. M. Beck (See prior above listing)	
Electra Mission Manager	R. L. Navarro (retired) NASA Wallops	
Project Coordination	H. A. Thompson (no longer at Bionetics Corp.) Bionetics Corp.	
Data Manager and Meteorological Coordinator	D. S. McDougal (retired)	
AGE Coordinator	R. C. Harriss (See prior above listing)	

2. APPLICATIONS AND DERIVATION

Potential usage and applications of the described data sets can be seen in the articles that comprise the Journal of Geophysical Research ABLE 2A Special Section (Vol. 93, No. D2 February 20, 1988) and the 1986 Spring AGU Meeting.

a. Calculated Variables

For convenience of the users, the calculated variables below are provided.

Mach Number, M:

$$M = \sqrt{5 * \left[\left(\frac{Q_C}{P_S} + 1 \right)^{(2/7)} - 1 \right]}$$

M = Mach Number
Ps = Static Pressure
Qc = Differential Pressure

Static Air Temperature, Ts:

$$T_S\,(°K) = \frac{T_T}{\left[1 + M^2 * \left(\frac{\gamma - 1}{2} \right) \right]}$$

T_S = Static Air Temperature (°K)
T_T = Total Air Temperature (°K)
γ = 1.4, ratio of specific heat of air at constant pressure and volume

True Air Speed, TAS:

$$TAS(kts) = M * a = M * 38.96695 * \sqrt{T_S}$$

TAS = True Air Speed (knots)
T_S = Static Air Temperature (°K)
M = Mach Number
a = Speed of Sound

Potential Temperature, θ:

$$\theta(°K) = T_S * \left(\frac{1000}{P_S} \right)^{0.2857142}$$

θ = Potential Temperature (°K)
T_S = Static Air Temperature (°K)
Ps = Static Pressure (mb)

Vapor Pressure, e :

e_{water} (mb) = [1.0007 + (3.46 * 10^{-6} * P_S)] * 6.1121* EXP[17.502 * T/(240.97 + T)]

e_{ice} (mb) = [1.0003 + (4.18 * 10^{-6} * P_S)] * 6.1115* EXP[22.452 * T/(272.55 + T)]

e = Partial Pressure of Water Vapor (mb)
P_S = Static Pressure (mb)
T = Static Air Temperature (°C) for Saturation Vapor Pressure
or
T = Dew/Frost Point (°C) for Partial Pressure of Water Vapor

Note:

1. ProjDP of zero or greater should be used to derive the partial pressure of water vapor w.r.t water (e_{water}) and the ProjDP less than zero should be used to derive the partial pressure of water vapor w.r.t ice (e_{ice}).

2. StatTempDegC and ProjDP parameters recorded in the P-3B data set are substituted to calculate saturation vapor pressure and partial pressure of water vapor, respectively.

3. TSDEGC and ProjDP parameters recorded in the DC-8 data set are substituted to calculate saturation vapor pressure and partial pressure of water vapor, respectively. Also notice in the DC-8 data set there is a redundant static air temperature measurement, TSCALC, which is calculated by DADS. Although TSDEGC and TSCALC track closely they can diverge by ? 1° at the low and high ends of the measurement range.

Specific Humidity, q:

$$q(g/kg) = \frac{0.622 * 10^3 * e}{(P_S - 0.377e)} \qquad q(ppmw) = \frac{0.622 * 10^6 * e}{(P_S - 0.377e)}$$

Mixing Ratio, r:

$$r(g/kg) = \frac{0.622 * 10^3 * e}{(P_S - e)} \qquad r(ppmw) = \frac{0.622 * 10^6 * e}{(P_S - e)}$$

Note:
ppmv = 1.608 * ppmw
ppmw = 0.622 * ppmv

Relative Humidity, %:

w.r.t. water,

$$RH_{water} = \frac{e_{water}}{e_{S_{water}}} * 100$$

w.r.t. ice,

$$RH_{ice} = \frac{e_{ice}}{e_{S_{ice}}} * 100$$

b. Graphs and Plots:

Interested readers should see the Journal of Geophysical Research, Vol. 93, No. D2, February 20, 1988, and documents referenced therein, for plots and the results of analysis of data.

3. DATA DESCRIPTION AND ACCESS

a. Format

See the GTE Data Format Document

b. Data Organization

Granularity

A general description of data granularity as it applies to the IMS appears in the EOSDIS Glossary. Aircraft data sets are available for each investigation for each flight. Surface level data are available on a daily basis.

c. Data Collection Status and Plans

All data available for the ABLE 2A mission are listed in the ABLE 2A Data Archive Table. No additional data products relevant to ABLE 2A are anticipated.

ABLE 2-A Data Archive

PI	Technique	Platform	Species
M. Andreae	Traps	Electra	DMS, CH3SH
E. Browell	LIDAR	Electra	Aerosol and Ozone profile
G. Gregory	Chemiluminescence	Electra	Ozone
Project	------	Electra	Altitude, latitude, longitude, ground track, true air speed, static air temp, dew point, static pressure, wind speed, wind direction
R. Rassmussen	Cryogenic Air Samples	Electra	C5H8, H2,CO, CH4, CO2, F-22, N2O, F-113, F-12, F-11, CH3CCl3, CH3Cl, C2H6, C2H2, C2H4, C2H2, C3H8, C3H6, I-C4, N-C4

G. Sachse	IR Laser Differential Absorption	Electra	CO
R. Talbot	Filters	Electra	Na, NH4, K, FO, AC, MSA, Cl, NO3, SO4, OX
R. Talbot	Filters	Electra	Particulate Organic Carbon
A. Torres	Chemiluminescence	Electra	NO
M. Andreae	Ground based samples	Ground	Rain Water Chemistry (Formate, acetate, oxalate, MSA, chloride, nitrate, sulfate, sodium, ammonium, potassium)
D. Fitzgerald	Ground based samples	Ground	Mean vertical velocity, mean temp, mean humidity, vertical velocity variance, temp variance, humidity variance, covariance wT, covariance wQ
P. Zimmerman	Ground based samples	Ground	Methane, CO, CO2, ethane, ethylene, acetylene, propane, propylene, i-butane, n-butane, 1-butene, i-butene, t-2-butene, c-2-butene, i-pentane, neopentane, n-pentane, 2-CH3-1-butene, 3-CH3-1-butene, isoprene, 1-pentene, t-2-pentene, c-2-pentene, 2-CH3-2-butene, cyclopenene, cyclopentane, neohexane, 4-CH3-1-pentene, 2,3,-dimethylbutane, 2-methylpentane, t-4-CH3-2-pentene, c-4-CH3-2-pentene, 3-methylpentane, 2-CH3-1-pentene, 1-hexene, n-hexane,t-2-hexene, c-2-hexene, 2-CH3-2-pentene, t-3-CH3-2-pentene, methylcyclopentane, c-3-CH3-2-pentene, benzene, 1-methylcyclopentene, cyclohexane, 2,4-dimethylpentane, 2-methylhexane, 3-methylhexane, 2,3-dimethylpentane, 1-heptene, n-heptane, 3-heptene, methylcyclohexane, toluene, 2,2,4-trimethylpentane, 2,3,4-trimethylpentane, 2,3-dimethylhexane, 2-methylheptane, 3-methylheptane, n-octane, 1-octene, ehtylbenzene, p&m-xylene, o-xylene, styrene, 1-nonene, n-nonane, 4-nonene, i-propylbenzene, 3-ethyltoluene, 2-ethyltoluene, 1,3,5-trimethylbenzene, 1-ethyltoluene, 1,2,4-trimethylbenzene, 1,2,3-trimethylbenzene, 1-decene, n-decane, alpha-pinene, camphene, n-propylbenzene, beta-pinene, delta-3-carene, delta-4-carene, alpha-phellandrene, beta-phellandrene, alpha-terpinene, gamma-terpinene, sabinene, myrcene, p-cymene
M. Garstang	Blis Sonde	Ground	Pressure, altitude, wind speed, wind direction, temperature, WB temp, dew point, relative humidity,

			ratio a/d, rate
M. Garstang	Rawinsonde	Ground	Pressure, altitude, wind speed, wind direction, temperature, P temp, dew point, relative humidity, azimuth, elevation, A rate
M. Garstang	Tethered Balloon	Ground	Pressure, altitude, wind speed, wind direction, temperature, WB temp, dew point, relative humidity, ratio a/d, rate
M. Garstang	Tethered Balloon	Ground	Pressure, altitude, wind speed, wind direction, temperature, WB temp, dew point, relative humidity, ratio a/d, rate
M. Garstang	Tethered Balloon	Ground	Pressure, altitude, wind speed, wind direction, temperature, WB temp, dew point, relative humidity, ratio a/d, rate
M. Garstang	Tethered Balloon	Ground	Pressure, altitude, wind speed, wind direction, temperature, WB temp, dew point, relative humidity, ratio a/d, rate

d. Data Access

The ABLE 2A data are available online through the GTE Data Archive or on a CDROM which can be ordered online through the LaRC ASDC.

e. Data Archive Center

The Atmospheric Science Data Center at NASA's Langley Research Center.

Contacts for Data Center or Data Access Information:

User and Data Services Group
Atmospheric Science Data Center
MS 157D
Langley Research Center
Hampton, VA 23681 USA
Phone: 757-864-8656
Fax: 757-864-8807
E-mail: support-asdc@earthdata.nasa.gov
Internet: http://eosweb.larc.nasa.gov

f. How to Cite the Data Collection

Publication of a portion(s) of the data archive should acknowledge the principal investigator(s) responsible for the data by referencing the appropriate manuscript in the Journal of Geophysical Research, Vol. 93, No.D2, February 20, 1988.

4. DATA CHARACTERISTICS:

a. Study Area

Airborne measurements were made over the Amazon, as indicated in figure 3. A more detailed description of the surface level environmental characteristics for the experiment region is provided in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 93, No. D2, February 20, 1988. Additional information may be found in other publications authored by the principal investigators or on the GTE home page.

Spatial Coverage

Flight missions were conducted during July through August 1988. The duration, altitude range, ascent and descent rate, and flight path of each mission varied depending on mission objective and environmental conditions. The nominal air speed ranged from 290 knots (approximately 334 mph) at 5.66 km altitude to 206 knots (approximately 237 mph) at 0.14 km.

Measurement Platform	Min Lat	Max Lat	Min Lon	Max Lon
Electra Aircraft	7.20S	37.10N	47.48W	76.30W
Ground sites	2.95S	3.15S	59.95W	59.98W
Sondes	2.95S	2.95S	59.95W	59.95W
Tethered Balloons	2.95S	2.95S	59.95W	59.95W
Merged Data	7.20S	37.10N	47.48W	76.30W

Spatial and Temporal Resolution

Resolution varies for each measurement. See the individual headers associated with each data file for specific information.

Grid Description

No data gridding or binning of data to a geographic grid occurred during data processing.

b. Temporal Coverage

ABLE 2A aircraft missions were conducted from July 11 through August 13, 1988.

Measurement Platform	Begin Date	End Date
Electra Aircraft	7/11/85	8/13/85
Ground Site	7/14/85	8/10/85
Sondes	7/15/85	8/5/85
Tethered Balloon	7/20/85	8/5/85
Merged Data	7/11/85	7/11/85

c. Parameter or Variable

Not all of the parameters are in each data set granule. Also, the ranges vary between data sets and between granules within each data set. Species measured are given in Harriss et al., [1988].

Parameter Description

The variables measured are standard atmospheric chemical and meteorological species requiring no further elaboration here.

Unit of Measurement

The units of measure vary widely depending on species and measurement environment and are addressed in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 93, No. D2, February 20, 1988.

Parameter Source

The instruments used in making the measurements are listed in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 93, No. D2, February 20, 1988.

Parameter Range

The ranges of data vary widely depending on species and measurement environment and are addressed in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 93, No. D2, February 20, 1988.

Sample Data Record

The GTE Data Format Document contains examples of each data set type.

d. Error Sources

The sources of error vary depending on species and measurement environment and are addressed in the papers included in the ABLE 2A special issue of the Journal of Geophysical Research, Vol. 93, No. D2, February 20, 1988, and/or papers referenced in that publication and readme files and/or header records associated with each data file.

5. USAGE GUIDANCE

a. **Known Problems with the Data**

None reported for the current archive version. See the readme files and header records included with each data set for information provided by the responsible investigator.

b. **Future Modifications and Plans**

The data sets submitted to the ASDC are considered final and no further updates are planned. However, modifications will be considered if requested by the investigators or otherwise justified.

6. ACQUISITION MATERIALS AND METHODS

Details of data acquisition and materials are addressed in the Journal of Geophysical Research ABLE 2A Special Section (Vol. 93, No. D2, February 20, 1988) and the 1986 AGU Spring Meeting.

7. REFERENCES

1. AGU Spring Meeting, Baltimore, MD, 19-22 May 1986.
2. ABLE 2A Special Section, Journal of Geophysical Research, Vol. 93, No. D2, February 20, 1988.
3. GTE Bibliography
4. Harriss, R. C., S. C. Wofsy, M. Garstang, E. V. Browell, L. C. B. Molion, R. J. McNeal, J. M. Hoell, R. J. Bendura, S. M. Beck, R. L. Navarro, J. T. Riley, and R. L. Snell, The Amazon Boundary Layer Experiment (ABLE 2A): Dry Season 1985, J. Geophys. Res., Vol. 93, No. D2, 1351-1360, 20 February 1988.

8. ACRONYMS

EOSDIS Acronyms | EOSDIS Glossary.

ABLE 2A - Amazon Boundary Layer Expedition - Dry Season
AGE - Amazon Ground Emissions Program
AGU - American Geophysical Union
ASDC - Atmospheric Science Data Center
DADS - Data Acquisition and Display System
EOSDIS - Earth Observing System Distributed Information System
GTE - Global Tropospheric Experiment

IAG - Instituto Astronomico e Geofisico
IMS - Information Management System
INPE - Instituto Nacional de Pesquisas Espaciais (National Institute for Space Research)
NASA - National Aeronautics and Space Administration
NCAR - National Center for Atmospheric Research
ProjDP - Project Dew Point
TSCALC - Static temperature, calculated by DADS
TSDEGC - Static temperature, measured directly, in Celsius
WFF - Wallops Flight Facility

9. Document Information

- **Creation Date:** November 2003
- **Revision Date:**
- **Review Date:**
- **Identification:**
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